UNIT B

Energy Transformations

A player races toward the goal. Her legs power her skates to keep ahead of the defence. She shifts to the left and shoots the puck high toward the top corner.

The puck soars toward the net. Muscles in the goalie's arm contract — and she makes a fantastic glove save. The crowd roars.

Hockey players' muscle cells transform the energy stored in the food they eat into the energy needed to contract muscles for skating, shooting, and making saves. Every hockey rink is home to many energy transformations.

- Halogen lamps transform electric energy into light energy.
- Furnaces transform the energy stored in fossil fuels into thermal energy.
- Natural gas produces thermal energy to cook hot dogs and hamburgers in the concession area.

In this unit you will investigate and describe energy transformations and conservation. You will investigate machines that generate electricity from other forms of energy. You will also study the importance of balancing the amount of food energy you take in against your energy requirements throughout your life.

Unit Contents

Chapter 5
Energy Conversions

Chapter 6
Electric Energy at Home

Chapter 7
Energy for Life

Chapter 8
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CHAPTER 5

Energy Conversions

Getting Ready...

- List three kinds of energy used around the home.
- Is all the energy that goes into a mixer used to mix the food in the bowl?
- Much of the energy that goes into a dragster is not used to move it down the track. Suggest two other ways the energy is used.

As Jamie Salé and David Pelletier complete a difficult move, training and a carefully controlled diet help them transform chemical energy into motion.

A dragster converts the potential energy of fuel into the mechanical energy that drives it down the track.

Science Log

Develop an Energy Transfer flowchart that uses a series of circles around a central point. At the centre, place the title: Energy I Use. List five ways you use energy in the first ring. List the source of each kind of energy in the second ring. List where each of these energies came from in the third.

Look at the photograph of Jamie Salé and David Pelletier. Stored energy from the food they have eaten allows them to complete difficult skating figures.

Fuel in the dragster works in a similar way to the food the skaters eat. That is because in energy transformations, food is a fuel. The roar of unmuffled engines (sound energy), flames exploding from exhaust pipes (sound, light, and thermal energy), and heat from engines and spinning tires (thermal energy) all point to these other energy conversions.

Consider how your life is tied to forms of energy and energy changing from one form to another. For example, you may depend on an alarm clock changing electric energy to sound energy to wake you up in the morning. For breakfast, you probably expect electric energy to convert to thermal energy to cook your eggs and toast.

How would your life be changed if it were not possible to convert kinetic and thermal energy?

In this chapter you will take a closer look at the sources of energy you use. You will examine ways some forms of energy convert to other forms of energy. In the dragster, one kind of energy transforms to several other kinds. You will also learn how scientists account for all energy conversions.

What You Will Learn

In this chapter you will learn:

- how to identify different types of energy
- that some energy conversions absorb energy and others release it
- how energy is converted and what is lost with each energy conversion
- about the law of conservation of energy

Why It Is Important

- You need energy from food in order to fuel your body. Like your body, vehicles and machines work because they change energy from one form to another. If you understand these energy conversions, you can live economically and in good health.

Skills You Will Use

In this chapter you will:

- investigate various forms of energy conversion
- design an apparatus that demonstrates energy converting from one form to another
- investigate temperature changes during chemical reactions
- analyze everyday technologies to identify the steps in energy conversions

Starting Point ACTIVITY

Do Pendulums Return to the Sender?

If you hold a pendulum at chest height and let go, will the swing come back and hit you?

Safety Precautions

- Release the pendulum. Do not push or throw it. Make sure that no one is in the way.
- Clean up the work area and wash your hands thoroughly at the end of the activity.

What You Need

500 g mass

butcher cord 3 m long

a hook or eye fastened to the ceiling 3 m from the wall

What to Do

1. Work in groups of four.
2. Tie the 500 g mass to the cord attached to the ceiling. Adjust the length of the cord so the mass is at your chest height when the cord is hanging down straight.
3. Hold the mass in your hand and walk backward, facing the mass. Position yourself so that the back of your head is against the wall.
4. Bring the mass up so it is just touching your nose. Release the mass. Without moving, wait for the mass to swing away and back to you. Note and record the height where it returns.
5. Repeat Steps 2 through 4 twice for each member of your group.
6. Graph your results.

5.1 Energy

Figure 5.1 Expert golfers like Tiger Woods master the way their muscles transfer energy to their club and then to the ball. They control the transfer of energy in ways that affect the golf ball's speed, direction, and behaviour. If a ball is hit one way, it will roll forward when it lands. Hit another way, it will roll back.

In order to get a good shot, golfers depend on energy changing from one form to another. For example, energy is converted in the golfer's muscles during the swing. When the club hits the ball, it transmits some of its energy to the ball.

Energy is the ability to do work. It can cause changes to the temperature, shape, speed, or direction of an object.

Where does your body get its energy?

- The human body converts stored (potential) energy in food into other forms of energy. Eating the right foods provides you with energy.
- Exercise speeds up the release of chemical energy from food stored in the muscles.
- Sleep gives the body's cells a chance to clear waste products and renew stores of energy.

Using Energy to Do Work

Like the people in the pictures, you use potential and kinetic energy throughout the day.

- In the morning, you depend on potential energy when you turn on a light as you get out of bed.
- At breakfast, you count on potential energy from the foods you eat to fuel your body.

Potential energy becomes useful energy when:

- electric energy is converted to light energy to illuminate your room;
- the stored energy in food is converted to kinetic energy as you walk out the door.

Figure 5.2 These tubers have **potential energy**. Sitting at the top of a hill, they are in a position to do work.

Figure 5.3 Kinetic energy is energy due to motion. As they slide down the hill, tubers are doing work.

READING Check

List three ways potential energy is useful to you.

Try This!

Practise serving a large, soft volleyball. Experiment with different ways of hitting the ball. What can you do to make the ball spin forward and backward when it hits the ground?

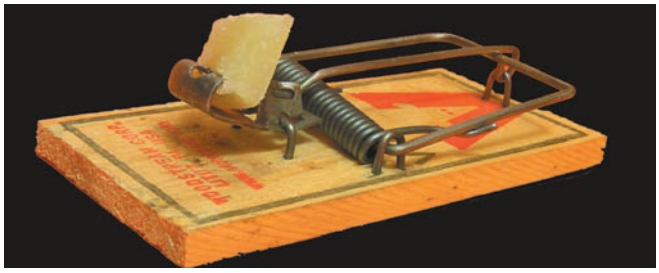
DESIGN & DO

INVESTIGATION 5-A

SKILL CHECK
- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Power a Car with a Mousetrap

Many mousetraps use a combination of potential and kinetic energy. In this activity, you will design a vehicle that uses both forms of energy to move a specified distance.



When the trigger of this mousetrap is tripped, potential energy in the spring is converted to kinetic energy of the swinging bar.

Challenge

Design and construct a vehicle that can move a distance of three metres by converting the potential energy in a mousetrap into kinetic energy.

Safety Precautions

- Take care when handling a "set" mousetrap.
- Clean up the work area and wash your hands thoroughly at the end of the investigation.
- Because of concerns about hantavirus, do not use mousetraps that have been around mice.

Apparatus

scissors

new mousetrap

Materials

bamboo skewers or a similar material for axles

4 lids from milk jugs or 35 mm film canisters — or similar materials for wheels

corrugated plastic signboard (10 cm x 20 cm)

duct tape

glue

rubber bands

Design Criteria

A. Using available materials, design a vehicle powered by a mousetrap.

B. The vehicle must convert potential energy in the mousetrap into kinetic energy. The design must show where each energy conversion takes place.

C. The vehicle can use elastics or other devices to transfer the potential energy in the mousetrap to energy that will move the vehicle three metres.

Plan and Construct

1. Sketch plans for the vehicle.
2. (a) Discuss how the potential energy will be converted into kinetic energy.

   (b) How will the energy conversions power the vehicle?
3. Before building the model, ask your teacher to check your plans.
4. Construct the model of your vehicle.

Check Your Understanding

1. Define "potential energy" and "kinetic energy." List three examples of each.
2. List the energies you depend on when you are:
   - **(a)** walking to school
   - **(b)** driving to the store
   - **(c)** turning on a computer
   - **(d)** listening to the radio

Key Terms

energy

potential energy

kinetic energy

5.2 Many Forms of Energy

We could not live without the many energy conversions that provide us with food, heat, and light. Without energy from the Sun or **solar energy**, life on Earth would not exist.

READING Check

Briefly explain how plants and animals use energy from the Sun.

Green plants use solar energy to produce a sugar called glucose. Plants use the energy from the glucose in their own growth. Animals cannot get energy directly from the Sun. When they eat plants, they use energy from the plant to fuel their own bodies.

We use past solar energy when we burn wood. Trees use the energy produced in leaves to make new cells we call wood. A campfire produces **thermal energy**. Thermal energy provides heat. Heat is produced when the particles in substances around the flame vibrate faster and faster. Like firewood, fossil fuels such as crude oil and natural gas contain stored energy from the Sun. This energy came from plants and animals that died more than 100 million years ago.

Try This!

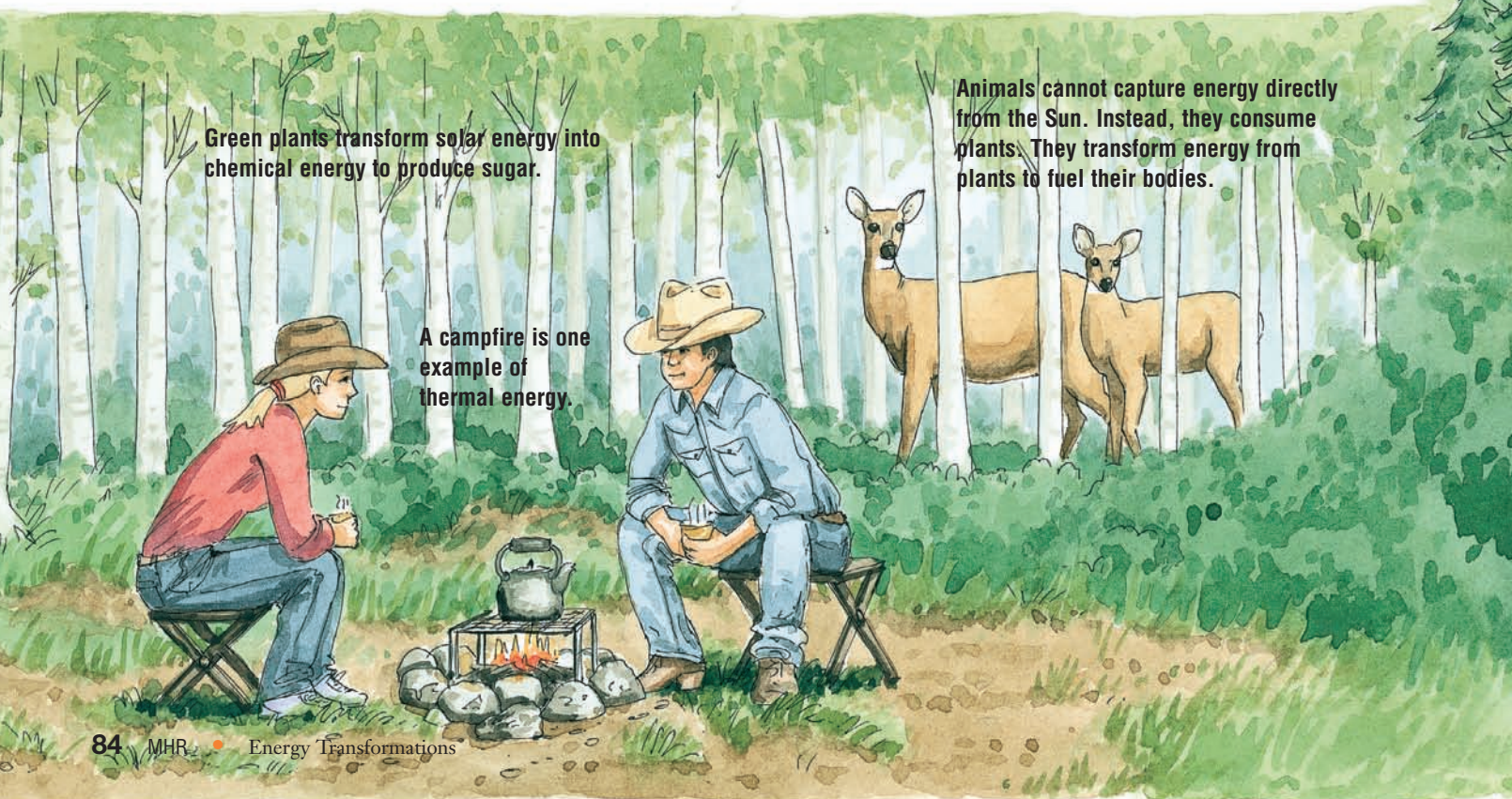
Unit A discusses many chemical reactions. Chemical reactions may involve the conversion of energy from one form to another form. Choose two chemical reactions from Unit A that are depicted in the illustrations on pages 84 and 85. For each, write out the basic word equation and describe the related energy conversion.

Some homes have solar panels that convert solar energy directly to electric energy.

Other common sources of energy include **wind energy** and **geothermal energy**. Windmills capture kinetic energy from winds. As the wind vanes turn, the windmill generates electric energy.

Alberta has many sites where volcanic activity within Earth comes close to the surface. This geothermal activity is a source of thermal energy. It heats water in hot springs.

Identify the forms and sources of energy in Figure 5.4.


Green plants transform solar energy into chemical energy to produce sugar.
A campfire is one example of thermal energy.
Animals cannot capture energy directly from the Sun. Instead, they consume plants. They transform energy from plants to fuel their bodies.

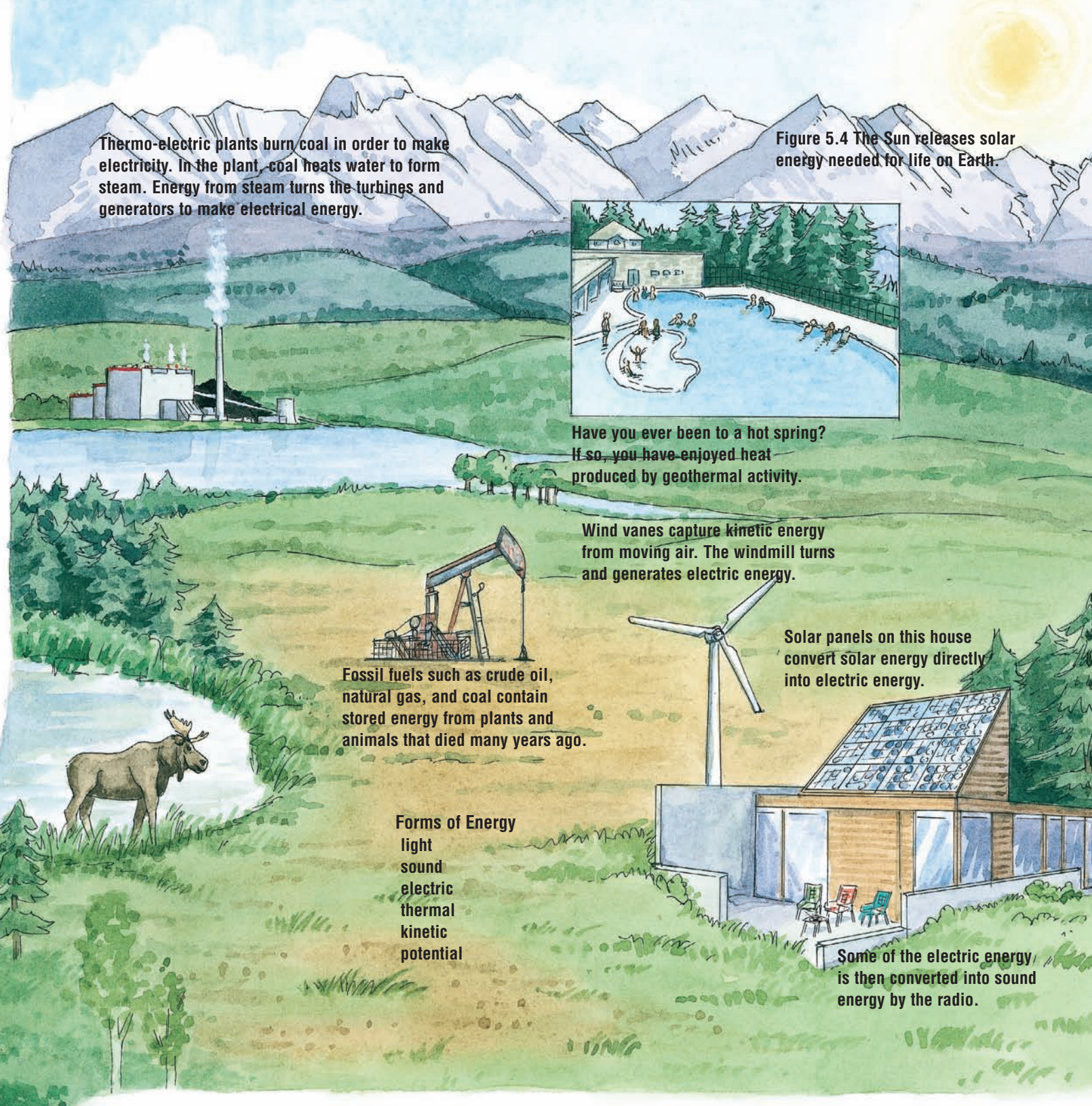

Thermo-electric plants burn coal in order to make electricity. In the plant, coal heats water to form steam. Energy from steam turns the turbines and generators to make electrical energy.
Have you ever been to a hot spring? If so, you have enjoyed heat produced by geothermal activity.
Wind vanes capture kinetic energy from moving air. The windmill turns and generates electric energy.
Fossil fuels such as crude oil, natural gas, and coal contain stored energy from plants and animals that died many years ago.
Solar panels on this house convert solar energy directly into electric energy.
Forms of Energy
light
sound
electric
thermal
kinetic
potential
Some of the electric energy is then converted into sound energy by the radio.

Figure 5.4 The Sun releases solar energy needed for life on Earth.

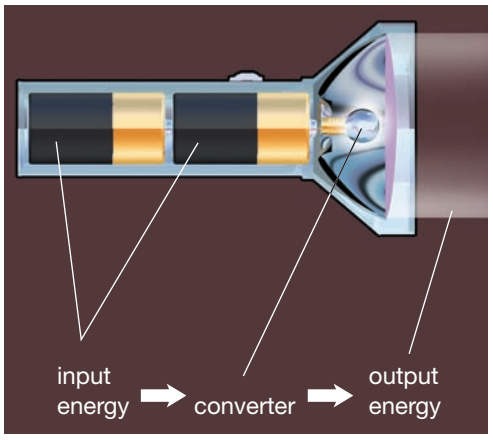
Check Your Understanding

1. List two ways the Sun's energy is converted for use.
2. Is thermal energy a form of kinetic energy? Explain.
3. What energy conversions take place from the eating of an apple to the energy used to throw a ball?

Key Terms

solar energy
thermal energy
wind energy
geothermal energy

5.3 Understanding Energy Conversion



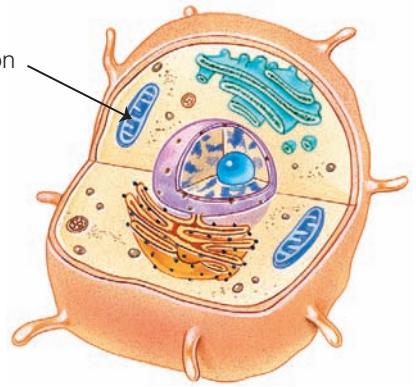
In order to do work, energy constantly changes from one form to another. Scientists use specific terms to describe what happens during this process.

- Energy that enters the system is called **input energy**.
- The system where energy is changed from one form into another is called a **converter**.
- The energy that leaves the system is called **output energy**.

Figure 5.5 The flashlight is one example of an energy converter.

READING Check

Sketch an electric tool that you use. Identify the three components of an energy conversion.



input energy → converter → output energy

input energy = chemical energy stored in glucose in muscle tissue

Athletes train so that their muscle tissue will convert energy in the most efficient way possible. Energy conversion occurs at the cellular level. Glucose is transported to the muscle cells by the blood.

converter = mitochondrion

The chemical energy in glucose is converted into another form of chemical energy that can be used for a specific purpose, such as muscle contraction.

output energy = movement of muscle cell

Muscle cells move by contracting.

Figure 5.6 As with every energy system, the conversion of energy from one form to another is never 100 percent efficient. Some energy is released as thermal energy. You feel this when your body warms up during heavy exercise.

How would the energy conversions during training affect the daily energy requirements of an athlete?

Chemical Conversions

The heat you feel during exercise is produced by a chemical reaction within the muscles of your body. Potential energy from food is converted to thermal energy.

Many chemical reactions produce thermal energy. In the investigation on the next page, you will learn what happens to temperature during a chemical reaction.

READING Check

What is chemical energy?

potential chemical energy from food → is converted to → kinetic energy for muscles to move

potential chemical energy from food → is converted to → thermal energy to keep you warm

Figure 5.7 Many energy conversions occur each time you exercise. The potential energy from the food you eat converts to chemical energy as the food breaks down during digestion. This chemical energy fuels your muscles. What energy conversions occur when a tennis or baseball player hits a ball? Use the terms potential energy, kinetic energy, and thermal energy.

DidYouKnow?

About 84 percent of Alberta's electricity is produced by burning coal. Combustion of coal produces a large quantity of thermal energy. Around the world, this chemical reaction has also been identified as a cause of acid deposition and climate change.

Figure 5.8 Commercial hot or cold packs such as these contain chemical potential energy. When the pack is twisted, a small container in the pack breaks and the ingredients mix. Depending on the ingredients, heat is either given off or absorbed.

Career CONNECT

Knowing how to ride a horse is only the first step if you want to lead trail rides into the mountains. You must also know about energy conversions.

The ride leader constantly watches how other riders and mounts are progressing. Are they overheating on climbs? Are they rested at the top?

Ride leaders also keep an eye on weather. Is it starting to get colder or hotter? If it is getting colder, do the horses and riders need to relax and eat something to maintain their energy? If it is getting warmer, do the horses and riders need a drink and salty snack to avoid losing energy?

If you are already learning about how to take care of horses, you have made the first step toward a job as a ride leader. Other steps include taking courses in first aid, CPR, and people management. As well as caring for horses, ride leaders need to know how to handle people in emergency situations.

Figure 5.9

CONDUCT AN

INVESTIGATION 5–B

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Chemical Reactions: Generating or Absorbing Heat?

Problem

What energy conversions happen during chemical reactions?

Prediction

1. Read the procedure for this investigation. What do you think will happen during each chemical reaction? Will the temperature of the materials stay the same, increase, or decrease?
2. Does a temperature change indicate an energy conversion?

Safety Precautions

- Handle acids only when wearing gloves, apron, and goggles.
- Stir the mixture with a stir stick, not a thermometer.
- If you spill or splash acid, notify your teacher immediately.
- If acid comes into contact with skin, flush continually with running water and ask a fellow student to notify the teacher immediately.
- Clean up the work area, clean the equipment, and wash your hands thoroughly at the end of each part of the investigation.
- Use a fume hood to collect gas produced during Part 2.

Apparatus

graduated cylinder
scale or balance and masses
thermometer
stir stick
scissors
tweezers
fume hood

Materials

citric acid solution
foam cups
baking soda
hydrochloric acid solution (1 mol/L)
magnesium (2–3 cm)

Procedure

Part 1: Citric Acid and Baking Soda

1. Use the graduated cylinder to measure 30 mL of citric acid solution. Pour this solution into the foam cup.
2. Measure and record the mass of the cup and citric acid.
3. Very carefully, place a thermometer into the citric acid. Make sure that the foam cup does not tip over. Wait until the reading stops changing. Record this value. Remove the thermometer.
4. Weigh out 10 grams of baking soda.
5. Add the baking soda to the solution in the cup. Use a stir stick to stir the solution. Mix it well.
6. Put the thermometer back in the cup. Watch the temperature carefully. Record the lowest or highest temperature that is reached.
7. Add and record what the total mass of the cup, the citric acid solution, and the baking soda was before the reaction.
8. When the action in the cup calms, measure and record the mass of the solution and the foam cup.
9. Dispose of the solution according to your teacher's directions.

Part 2: Hydrochloric Acid and Magnesium Teacher Demonstration

1. Measure out 30 mL of hydrochloric acid solution. Pour it into a clean cup.
2. Measure and record the mass of the cup and acid.

3. Place the thermometer into the solution in the cup. Wait until the thermometer reading stops changing. Record this value. Remove the thermometer.

4. Cut approximately 0.5 cm from the ribbon of magnesium. Measure and record the mass of the magnesium.

5. Put the thermometer back in the cup. Place the cup under a fume hood. Use tweezers to drop the magnesium, gently, into the hydrochloric acid.

6. Put the thermometer back in the cup. Hold the cup as you place it under a fume hood. Use a stir stick to stir the solution well. **CAUTION:** Do not breathe the vapours. Do not splash the liquid.

7. Record the minimum or maximum temperature reached.

8. Calculate and record the mass of the cup, acid, and magnesium before the reaction.

9. When the action in the cup stops, measure and record the mass of the solution and foam cup.

Analyze

1. Calculate and record the temperature change for each reaction. To do this, subtract the lowest temperature from the highest.
2. **(a)** Which reactions demonstrated an energy conversion by producing or losing heat during the chemical reaction?

   (b) Identify whether each reaction produced or lost thermal energy during the chemical reaction and conversion.
3. For each reaction, describe two additional pieces of evidence that suggest a chemical reaction was happening.
4. In each reaction, has there been a transfer of energy? Explain why you think this way.

Conclude and Apply

5. Did any change of mass occur? Explain why you might or might not expect a change of mass to occur.

DidYouKnow?

The concrete used in foundations, sidewalks, and to hold bricks together undergoes a chemical reaction as it hardens. At first, cement powder, water, sand, and gravel are mixed together and can be poured. As the mixture sets, it gives off thermal energy and hardens.

Figure 5.10

INVESTIGATION 5-C

SKILL CHECK
- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Energy Conversions Are Hard to Escape

Think About It

Is there anything you do that does not involve energy conversions? Use this activity to help you decide.

What to Do

1. Copy the table shown here into your notebook. Leave enough room for six empty rows.

The Converter	Input Energy	Output Energy	Is Thermal Energy Given Off?
flashlight bulb	chemical energy (battery)	light energy (bulb)	yes

B. Snowblower engine working

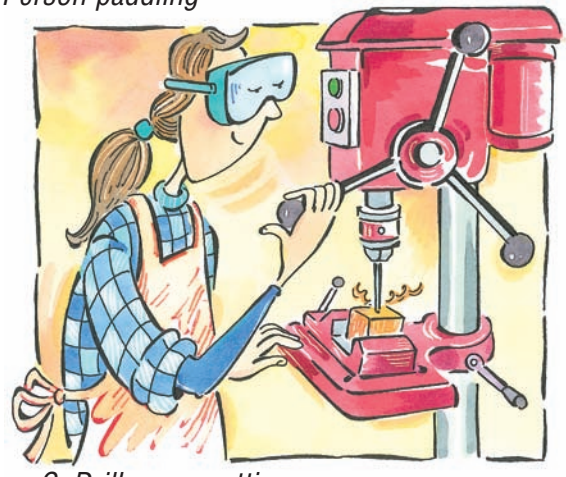
2. For each cartoon, identify the energy converter, the kind of input energy, and the kind of output energy.

3. Decide and record whether thermal energy is given off.

Analyze

1. In these examples, are some types of output energy more common than others? Explain.
2. In many energy conversions, some thermal energy (heat) is dissipated. When could thermal energy in these six examples be considered wasted energy? Explain.

A. Person paddling



C. Drill press cutting

D. Hobby rocket taking off

E. Person trampolining

F. Person eating a sandwich

Internet CONNECT

www.mcgrawhill.ca/links/science.connect2

Amusement park rides, including roller coasters, rely on energy conversions. To learn more about how roller coasters convert potential energy into kinetic energy, go to the above web site. Then go to Unit B, Chapter 5, and then to Physics of Roller Coasters. Build your own roller coaster and then test it out to see if it works.

When Is Thermal Energy Wasted?

In Investigation 5–C, you learned that thermal energy is released during most activities. In many cases, this energy is waste energy. It is not used or needed for the activity. In some cases, such as during moderate physical activity, the thermal energy is not a problem. But it can become a problem on extremely hot days, when athletes may get overheated.

Many machines also produce excess thermal energy. The thermal energy produced by many machines often interferes with their operation. The student using the drill press must be careful to avoid overheating the drill, for example. This could result in a piece of work with burn marks. Later in this chapter, you will see how car manufacturers are now trying to use thermal energy that would otherwise be wasted.

READING Check

Give two examples of waste thermal energy that might cause problems.

Check Your Understanding

1. What three components are necessary for an energy conversion?
2. Identify the energy conversions that take place when the inside of a car heats up when the car is left in the Sun.
3. List three examples of energy conversion during which heat is being given off.

Key Terms

input energy
converter
output energy
chemical energy

5.4 Conservation of Energy

Figure 5.11 When we use energy to perform work such as drying our hair, do we use all of the available energy or is some wasted?

What types of energy are produced by a blow dryer?

- Thermal energy provides the heat to dry your hair.
- There is kinetic energy in the moving air.
- Some electricity is converted to sound energy.
- The glowing elements produce light energy.
- The fan that moves the air is a motor. Friction produces thermal energy that is not used to dry your hair.

You could measure the electric energy that goes into the blow dryer. If you compared it to all these forms of output energy, you would find that the two are equal. Input energy is equal to output energy.

Scientists refer to this understanding as the **Law of Conservation of Energy.** The Law of Conservation of Energy states that energy cannot be created or destroyed. Energy can only be changed from one form of energy to another.

Another way of thinking about this is to compare energy to money. Imagine you had $10 in assorted coins. When you counted the coins a few days later, you noticed that you did not quite have $10. Likely, you would begin searching in your pockets, under the couch cushions, and around the house until you found the missing change.

Energy is like this. It does not just disappear. If some energy appears to be missing, it is because you have not identified all forms of energy present.

READING Check

Use an example to explain the Law of Conservation of Energy.

SCIENCE Myths

Every year, people spend a lot of money trying to design a machine that will run by itself. Such a perpetual motion machine would run on and on without maintenance or fuel. Wouldn't it be nice to have a car like that?

Actually, there can be no such thing. For a perpetual motion machine to work, it would have to have no waste energy. So far, no one has found a mechanism that does not lose at least some energy to heat or friction.

Law of Conservation of Energy

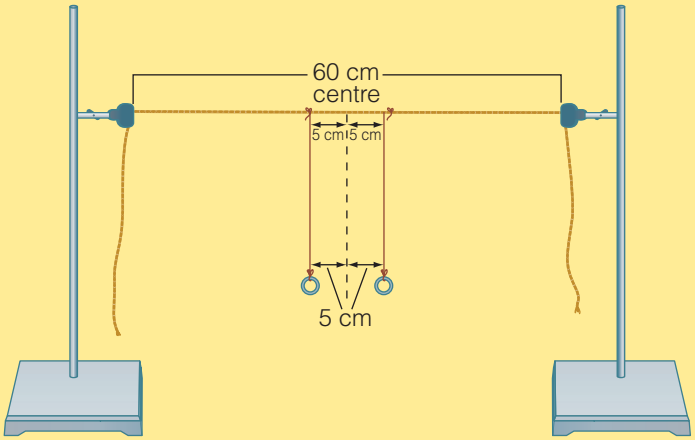
input energy = output energy

Figure 5.12 For any energy conversion, the amount of input energy is the same as the amount of output energy.

Find Out ACTIVITY

Do Swinging Pendulums Demonstrate the Law of Conservation of Energy?

Can energy from one swinging pendulum transfer to another?



What You Need

2 ring clamps

2 retort stands

metre stick

felt marker

3 pieces butcher cord
(1 piece 1 m long, 2 pieces 50 cm long)

6 washers (2.5 cm)

What to Do

1. Clamp the ring clamps to the retort stands 50 cm above the base. Use the 1 m piece of butcher cord to join the retort stands by tying each end of the cord to a ring clamp. Pull the retort stands away from each other until the cord is taut.

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

2. There should be about 60 cm between the ring clamps. Measure the actual distance. Divide the distance by two. Use this number to find and mark the centre of the taut cord.
3. Put another two marks on the cord 5 cm on either side of the centre mark.
4. Tie three washers to one end of each of the 50 cm pieces of cord. Tie the other end of each cord to the horizontal cord 5 cm from the centre. These cords or pendulums must be the same length.
5. Read Step 6. Discuss what you expect will happen to the second pendulum when you swing the first one.
6. Make sure both pendulums are at rest. Raise one pendulum carefully so it will swing at right angles to the horizontal cord. Release the pendulum.

What Did You Find Out?

1. What happened to the second pendulum when the first one started to swing?
2. Did the first pendulum continue swinging?
3. Did the second pendulum swing at about the same height as the first?
4. Explain how this pendulum activity demonstrates the Law of Conservation of Energy.
5. **(a)** When did the pendulum have its greatest potential energy?
   (b) When did it have its greatest kinetic energy?

Check Your Understanding

1. List three kinds of energy that come from a blow dryer.
2. Most of the energy produced by a car engine is not used to make the car move. Where does the rest of the energy go?

Key Terms

Law of Conservation of Energy

5.5 Energy Conversion Systems

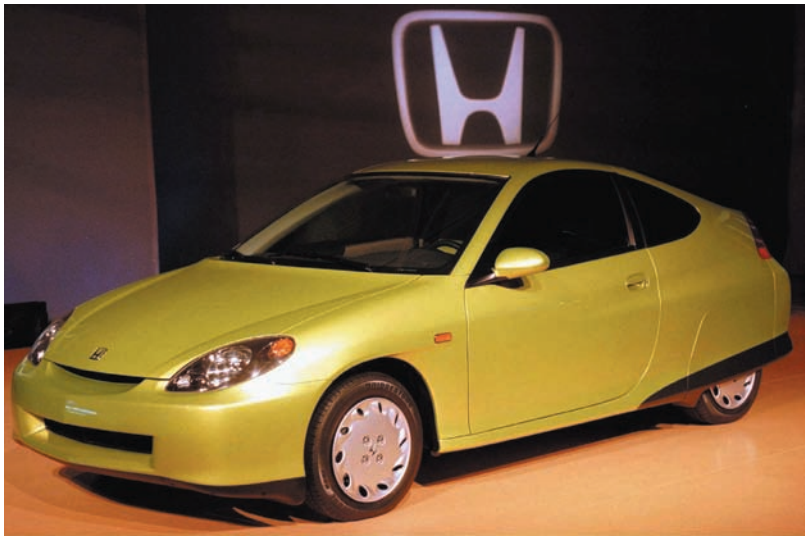


Figure 5.13 The Honda Insight uses a small gasoline engine that runs at a constant speed in order to charge batteries and power electric motors that drive the car. Since the gasoline engine is small and runs at a constant speed, the car uses less fuel. As a result, it is less polluting.

Touch the hood of a car that has been for a long drive. The hood is hot. When you touch a light bulb that has been on for a while, it is hot enough to burn your fingers. Car engines and light bulbs are designed to convert energy from one form to another. As well as running a car and lighting a room, both convert some of their potential energy to other energies.

Gasoline engines produce a lot of sound and thermal energy, as well as the wanted kinetic energy. Only about one third of the chemical potential energy of the gasoline that goes into a car engine is used to move the car. No wonder people want cars that convert energy more efficiently.

All machines convert some energy in ways that we do not want or use. Even electric motors waste a little energy to sound and friction. Although the amount of input energy equals the amount of output energy, some of the output energy in all machines is not usable.

Law of Conservation of Energy

input energy = **output energy**

OR

input energy = **useful output energy** + **waste output energy**

Figure 5.13 You can now add to your understanding of the Law of Conservation of Energy. For any energy conversion, the amount of input energy is the same as the amount of output energy. Some output energy is useful. Other output energy is wasted.

READING Check

Why is usable energy output always less than energy input?

DidYouKnow?

Less than one fifth of the energy that goes into a light bulb produces light! For $1 in electricity, you get less than 20¢ worth of light.

Internet CONNECT

www.mcgrawhill.ca/links/science.connect2

The mule is a hybrid animal. It is bred from a horse and a donkey, two animals of different species. Hybrid cars look and act like cars, but … Go to the above web site, then to Unit B, Chapter 5, and Honda Insight to find out how the Honda Insight is a different variety of car. Find out how the special braking system saves energy.

DESIGN & DO

INVESTIGATION 5–D

SKILL CHECK
- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Input and Output Energy

Challenge

Design and construct a working model that converts energy. Your model will turn a windmill that your group has created.

Safety Precautions

- Clean up the work area and wash your hands thoroughly at the end of the investigation.

Apparatus

electric fan

Materials

paper clips
Popsicle™ sticks
construction paper
tacks or pins
glue
tape
stapler
scissors

Design Criteria

A. Using the apparatus and materials supplied, design and build a windmill that demonstrates at least two energy conversions.

B. With the last energy conversion, the windmill must turn.

C. You must plan, construct, and use the model in one period.

Plan and Construct

1. Review and list the three components of all energy conversions.
2. Sketch a simple windmill design. In the sketch, include the form of energy that will turn the windmill.
3. List the apparatus and materials you need for your model. Include a set of procedures for building and using the model.
4. As you plan, identify the input energy, converter, and output energy for each energy conversion.
5. Have your model design approved by your teacher, then construct the windmill.

Evaluate

1. What safety precautions did you include in your procedures?
2. Be prepared to show your teacher how your windmill has at least three energy conversions.
3. Did your model successfully turn the windmill?
   - **(a)** If not, list changes you would suggest so another model would turn the windmill.
   - **(b)** If it did, how could you make the windmill turn even faster?
4. **(a)** In your model, how was input wasted?
   - **(b)** How might you revise the plans for your model so it wastes less energy?

Check your Understanding

1. Explain why input energy is greater than useful output energy.
2. Sketch two machines that have not been discussed but that you are familiar with. On the sketch, identify where there is waste output energy.

CHAPTER

5 Review

Key Terms

energy
potential energy
kinetic energy
solar energy
thermal energy
wind energy
geothermal energy
input energy
converter
output energy
chemical energy
Law of Conservation of Energy

Reviewing Key Terms

If you need to review, the section numbers show where these terms were introduced.

1. In your notebook, write the correct term or terms to complete each of the following sentences.

(a) An object in motion has _____ (2 words). (5.1)

(b) The ability to do work is _____. (5.1)

(c) Energy from the Sun is called _____ (2 words). (5.2)

(d) Most energy conversions give off energy in the form of _____ (2 words). (5.3)

(e) According to the _____ (5 words) , energy can neither be created nor destroyed. It can only be changed from one form to another. (5.4)

(f) When two or more substances react chemically with each other, they produce _____ (2 words) . (5.2)

(g) An orange hanging from a tree has _____ (2 words). (5.1)

(h) Three essential components to consider when energy transforms from one form into another are _____ (2 words), _____ , and _____ (2 words). (5.3)

Understanding Key Ideas

Section numbers are provided if you need to review.

2. A student coasts downhill to school. When do he and his bicycle have potential energy? When do they have kinetic energy? Explain the difference. (5.1)

3. Name two energy converters that capture energy from the Sun. (5.2)

4. Examine the picture of the baseball player shown here. Identify the following: (5.3)

(a) input energy

(b) the converter of energy

(c) output energy

Developing Skills

5. Why is it important to develop machines that convert as much energy as possible into useful output energy? (5.5)

6. Many machines convert input energy into thermal energy that is wasted. List three machines that convert input energy to useful thermal energy. (5.3)

7. Identify the energy conversions used to create excitement in this ride. (5.3)

Problem Solving/Applying

8. Consider a person playing a guitar and a person on a skateboard. (5.2, 5.3)

(a) For each person, identify the input energy, energy converter, and output energy.

(b) What form of energy is lost to the environment in each case?

9. Identify at least three amusement park rides that use potential energy or kinetic energy to provide excitement. Some use both. Explain how each ride uses these energies to provide a thrill. (5.1)

10. To make a glow stick work, you bend and then shake the stick. The light stick will glow with a yellow-green light. What do you think causes this? (5.3)

Critical Thinking

11. Many energy conversions include the release of thermal energy or heat. List one energy conversion that does not result in the release of heat. (5.3)

12. If you had left the two pendulums in the Find Out activity on page 93 to continue swinging, they would eventually have come to a stop. Does this mean the Law of Conservation of Energy is wrong? Explain. (5.4)

Pause & Reflect

1. Study the skaters shown in the chapter opener on page 80. Identify at least three types of energy and their converters.

2. Check your original answers to the Getting Ready questions. How has your thinking changed? How would you answer these questions now that you have investigated the topics in this chapter?